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A STUDY OF MASS FLOW IN THE MASSIVE SPECTROSCOPIC BINARY HD47129

Final Technical Report

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A Study of mass flow in the Massive Spectroscopic Binary HD47129

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FINAL TECHNICAL REPORT

HD 47129 is a double-lined spectroscopic binary with a period of 14.3961 days and a visual magnitude of V = 6.06. The system is of particular note because optical data indicate that the mass of the primary and secondary are each close to 60 $M_\odot$, making it the most massive binary known (Hutchings and Cowley, Ap. J. 206, 490, 1976).

Using the Copernicus U2 spectrometer, observations were obtained of the system on eight occasions, starting on March 2 1977. A spacing of two days was placed between each set of observations; therefore the orbital phase of the system was almost exactly the same during the first and last observations. During each observation the U2 spectrometer scanned the P Cygni profile of the 1176Å C III line system between 1160 and 1194Å and also scanned the P Cygni profile of the 1242Å N V line system between 1220 and 1253Å. Adequate signal-to-noise was obtained on each occasion with a maximum signal in the emission peaks of 50-60 Copernicus 14-second counts. Whilst the U2 spectrometer was performing these scans the U1 spectrometer was programmed to scan between 1029 and 1045Å in order to cover the O VI P Cygni line profile. However due to the faintness of the star and the lower sensitivity at these wavelengths, the signal-to-noise ratio was inadequate for searching for line variations, although red-shifted emission was definitely present. Therefore the remainder of this report will discuss only the U2 data.

Definite variations correlated with orbital phase were observed to occur in the C III and N V line profiles. The data appear to be interpretable in terms of a model whereby each profile consists of a non-varying P Cygni component (blue-shifted absorption and red-shifted emission) due to a normal stellar wind from the primary, superimposed upon which is an emission component varying with orbital phase and associated with the secondary. The reasons for the conclusion are outlined below.

The terminal velocity of the wind, deduced from the short wavelength edge of the blue-shifted absorption component, is found to be 3000 km/s from both the C III and N V data and does not vary with orbital phase. The absorption component of the N V line is nearly saturated (i.e. reaches near - zero flux) whereas the absorption component of the C III line is not saturated. The flux in the emission wing of the N V line varies with phase whereas the flux in the absorption core does not. On the other hand, the flux in the emission wing and absorption core of the C III line vary in phase together and by approximately the same amount. This behaviour implies that the line dependent excess emission originates close into the primary and secondary at the base of the mass loss flow, such that the large optical depth in the N V line prevents any excess emission being seen in the blueward displaced absorption component, whereas the low optical depth in the C III line allows variations to be seen in the absorption wing. The excess emission in the C III line has a width of ± 1000 km/s and peaks in intensity at phase 0.3, corresponding to the primary approaching and secondary receding. The excess emission disappears at phase 0.7, corresponding to the secondary in front and primary behind. This implies that the emitting region is located either at the side of the primary facing away from the secondary or at the side of the secondary facing the primary. Since it is more physically plausible to have excess material in the region between the primary and secondary rather than at their outward facing sides, it is concluded that the region giving rise to the excess emission is located close to the secondary.

Infrared photometry of HD 47129 between 2.2 and 10 μm has been obtained by one of us (M.B.) in collaboration with Dr. M. Cohen, Berkeley. The flux level at 3.6 μm and 10 μm shows strong variations with phase, the minimum excess flux level being interpreted as excess emission by the stellar wind only, allowing the mass loss rate of the system to be determined quantitatively. The nature of the emitting region near the secondary is currently being studied and the results of the research will be written up as soon as this study has been completed. The paper describing the results will be submitted to the Astrophysical Journal.